hematite ore fields. When the hills are of sufficient elevation the ore appears with remarkable persistency as a nearly horizontal bed, outcropping along the sides and near the crests of the hills or "buttes" forming the rolling country of the neighborhood. The formation is of late geological age. A section would represent a soft sandstone, on which the ore lies, with a seam of clay generally between the ore and the stone. The ore is capped by a thin layer of ferruginous sandstone, while on top of this is surface sand. The ore is of the bog variety of brown hematite, varying in physical structure from compact masses to laminated and in some cases coarsely granular ore, and in color from light brown to nearly black. Occasionally glossy surfaces and incipient pots and boryoidal forms are found in the talus, resulting from the ledges breaking away. The physical characteristics are such as to indicate an ore which smelts readily, and this expectation is borne out by the operation of blast furnaces. The ore is won at low cost, the sand covering being removed by scrapers from a large area, and the bed of ore, 24 inches in thickness, with the cap rock, is then broken up by means of picks, the ore being roasted in piles and transported to the blast furnaces. These deposits are generally credited as remnants of the floor of a lake or lakes, channels made by subsequent erosion having formed the buttes or hills. The view is taken at New Birmingham, Cherokee county, Texas. A report on "The iron region of northern Louisiana and eastern Texas" was prepared for the House of Representatives.(a) The method of exploiting illustrated is also followed in mining the outcropping carbonates in portions of Ohio and Kentucky.

Brown hematite mining near Anniston, Alabama.—The occurrence of this class of ore in northeastern Alabama is generally in pockets, some of them of unusual magnitude. The one illustrated shows exploitations carried around masses of ocherous clays. The line of demarcation between the "cover" or stripping and the ore which underlies it can be distinctly seen. After the cover is removed and the ore taken out (which in the case illustrated is done with a steam shovel) the ore is conveyed to washers, then put on cars which haul the ore to the furnaces. Some of the large deposits of similar ores in Alabama and Tennessee have excellent equipments of handling and washing machinery which permit of producing ore at low cost.

Magnetite mining at Cornwall, Pennsylvania.—This plate illustrates a soft magnetite mine, representing the second working on the Big Hill of the Cornwall mines. The breadth of the ore deposit in Big Hill is about 400 feet. On 3 sides is an outcrop of trap, descending from the brow of the hill to water level. The ore mass rests against the sloping face of the trap dike, overlying and abutting against it. The function of this trap rock has been a preservative one, resisting erosion and preserving above water level a portion of the ore mass, which otherwise would have been swept away. The ore mass is a regular stratified formation, sloping southeastward against the edge of the mesozoic rocks of the South mountain and rising eastward into the air. Erosion has divided the deposit into 3 hills, separated by water courses, and bore holes indicate a saucer-shaped ore body below water level. This deposit is considered as having experienced two, and by some authorities three, stages of growth: first, a formation of pyritiferous lime shales, then a brown hematite formation, and finally a magnetite, retaining its original place and general stratification, but being reduced somewhat in bulk. The iron ore is removed by a system of terraces in advance of each other, on which railway tracks are laid and extended in as the ore is mined. The ore is broken down by rock drills and hand power and loaded into railroad cars. This deposit, of which the illustration represents one of a number of workings, supplied about one-half of the iron ore output of Pennsylvania in 1889, and its total output to that date exceeded 10,100,000 long tons. It is an instance of phenomenally cheap mining, as the entire work is carried on by "open cut", and the soft character of the ore requires but a small amount of explosive per ton. A full description of the deposit as it was in 1880 appears in the Tenth Census, volume xv, pages 223 to 229. Since 1880, 4,690,259 long tons have been taken from the Cornwall ore hills.

Magnetite mining at Mineville, New York.—This plate is a view of the Old Bed 21 mine, representing an exploitation producing hard crystalline magnetite, which is there found in lenses of great size. It is broken down by means of rock drills, hauled to the surface by inclined skip roads, and discharged directly into railroad cars. The view is taken at a depth of 350 feet below the surface, looking toward the skip roads, and illustrates the enormous ore pillars which support the roof of the underground workings. The deposits of magnetite in the vicinity of Mineville have contributed, including 1889, over 9,500,000 long tons of iron ore.

The mines produce two distinct varieties of ore, one, known as Old Bed 21 ore, being a magnetite carrying apatite in such quantities as to raise the phosphorus beyond the bessemer limit, and the other being a magnetite carrying a siliceous gangue, but very low in phosphorus, known as New Bed ore. These general designations apply to ores obtained from various openings, the first portion of the commercial name Old Bed being derived from the original opening made in 1824, from which a large amount of ore has been won in workings extending 1,100 or 1,200 feet on the slope to a vertical depth of 300 feet. The No. 21 opening, which supplies the second portion of the commercial name for the ore, lies 200 feet south of the Old Bed opening, was started in 1829, and is one of the most impressive mines to view in the world. The massive pillars of ore supporting the roof (also of ore), capped with rock to within 50 feet of the surface, are exposed in the great open pit to a height of 300 feet,

a Executive Document No. 195, Fiftieth Congress, first session.

MAGNETITE MINING AT MINEVILLE, NEW YORK.

(See pages 22, 23.)

while the chambering extends much beyond the face and to a depth of about 350 feet vertically from the surface, the distance along the slope being 700 feet.

The openings producing New Bed ore cover a greater territorial area on account of being made upon a vein which is apparently continuous, but divided into two or three layers, while the various deposits of Old Bed ore seem to be a series of lenses lying in echelon or in nearly parallel veins of varying thickness and dip. The present shipments of New Bed pure ore, made up from daily analyses, show iron 66 and phosphorus 0.025 per cent, and New Bed lean ore carries about 55 per cent of iron, with phosphorus inside of the bessemer limit. The Old Bed 21 ore yields iron 66.18 and phosphorus 0.5 to 2.5 per cent.

Occasional horses of rock cut the Old Bed lenses, while the New Bed has a series of faults of pyritiferous material, but sulphur is not found in the ore. On the other hand, pockets of ore approaching chemical purity are met with. From one of these over 40,000 tons of ore were won during 1889, which averaged 68.6 per cent of iron and 0.033 phosphorus. One-third of all the analyses of ore from this pocket showed 70 per cent or over of iron.

RED HEMATITE MINING AT IRON MOUNTAIN, MISSOURI.—The dip of the ore is shown quite plainly. On the left is the porphyry "foot wall" sloping down under the ore; on the right the "hanging wall" of limestone and sandstone, the ore being found between the hanging and foot walls. The photograph is a part of the celebrated Iron mountain, where the ore is broken down, loaded into tram cars, several of which are seen in the illustration, hauled up the shafts, and discharged into railroad cars or on dump piles. Originally the Iron mountain deposit was worked by removing a capping of ore, and subsequently a considerable open cut was made. Lately much of the ore has been taken from the underground workings, the chief source of supply being a talus covering the original hillside, which was subsequently covered by later deposits. At Iron mountain lower grades of ore, after being mined, and some of the older dump piles, are hydraulicked and jigged. Professor Potter says the mountain is composed of red, brown, with some bluish porphyry, all more or less distinctly bedded, and the beds dip away on all sides with the surface slopes, thus exhibiting a rude, yet well marked, dome-like structure. The same dome form appears in the main ore vein, the top of which was originally exposed for an acre or more at the summit of the hill. Cutting through this in the subsequent working, the vein was found to dip away on all sides with the surface slopes, but at a steeper angle, following to some extent the bedding of the porphyry, yet inclining more rapidly. In removing this dome an open cut was carried down 130 feet below the original top of the hill, and the marginal vein forming an irregular ellipse 1,000 by 500 feet, as well as the interlacing veins within this ellipse, were exploited.

One of the most interesting features of the Iron mountain deposit is what is locally known as the "old surface ore", described by Professor Potter in 1884 as follows:

> Over the whole western side of the original hill, and dipping away with increasing thickness, may be seen a very ancient hill of surface ore, composed of irregular and partly rounded fragments of black, somewhat decomposed, ore. This passes beneath the overlapping sandstone and limestone below, forming in the lower bed of the latter a remarkable ore conglomerate with limestone cement. It will undoubtedly be found stretching away down the ancient hillside to where the latter runs into the bottom of the valley below the silurian beds. The quantity of ore stored up in this interesting period must be very large indeed, judging from the developments already made, and the great area over which it is found, outcropping well upon the sides of the hill and following down the slope, always with increasing thickness beneath the covering of hardened clays and shales. Comparatively little clay or foreign matter, and no hard rock at all, occurs with the fragments of rich black ore.

RED HEMATITE MINING, TOWER, MINNESOTA.—The plate shows a hard red hematite mine at Soudan, near Tower, Minnesota, where the iron ore is interbedded with jasper in folded and crumpled beds that occur in what is locally called the Keewatin formation. The lenses of ore now being worked appear to lie in echelon between nearly vertical walls, the foot wall being a slate and the hanging wall banded jasper and "soap rock". Both are well illustrated in the cut. The ore lenses exploited are found on two nearly parallel hills, but the ore has also been found by drilling between these ridges. Where ore outcropped or was found close to the surface of the ground it was exploited by large open cuts. At present, however, most of the ore is won by underground workings carried below the floors of these open exploitations. The ore, which is hard and dense, carries high percentages of iron and but small amounts of deleterious ingredients. It constitutes a large proportion of the charge used at the blast furnaces in Illinois, and is also shipped to blast furnaces near the Atlantic seaboard, the purity of the ore permitting it to stand long transportation. From the iron-ore mine openings near Tower about 2,000,000 long tons of ore have been won since their opening in 1884. A monograph upon the iron ores of Minnesota, published by the State Geological and Natural History Survey, presents illustrations of other workings on the Vermilion range.

IMPORTATIONS OF IRON ORE INTO THE UNITED STATES.

Reference has been made as to the quantity of foreign iron ore used, and an investigation of this subject is properly associated with a discussion of domestic iron ore production.

The importations of iron ore into the United States during the calendar year 1889 have been supplied by Major S. G. Brock, chief of the bureau of statistics of the Treasury department. The total amount received during the calendar year 1889 was 853,573 long tons, valued at $1,852,392. This ore was shipped from the following countries, contributing in the order named:

IMPORTS OF IRON ORE IN 1889, BY COUNTRIES.

[Long tons.]

COUNTRIES.	Quantity.	Value.
Total	853, 573	$1, 852, 392
Spain	298, 568	621, 481
Cuba	243, 255	535, 524
French Africa	97, 583	180, 607
Italy	87, 410	228, 104
England	54, 496	111, 638
Greece	28, 955	32, 880
Newfoundland and Labrador	14, 450	43, 100
British Columbia	13, 070	27, 860
Portugal	6, 659	15, 151
France	6, 565	17, 911
Quebec, Ontario, Manitoba, and Northwest territory	4, 001	10, 097
Turkey in Asia	2, 870	27, 265
Germany	1	24

SUMMARIZED IMPORTS OF IRON ORES.

[Long tons.]

COUNTRIES.	Quantity.	Value.
Total	853, 573	$1, 852, 392
British possessions in North America	32, 211	81, 057
Cuba	243, 255	535, 524
Europe	477, 654	1, 027, 249
Asia	2, 870	27, 265
Africa	97, 583	180, 607

The bureau of statistics has no data to demonstrate that the ore was mined in the country from which shipment was made; but little, if any, of it should be credited to other territory than above noted.

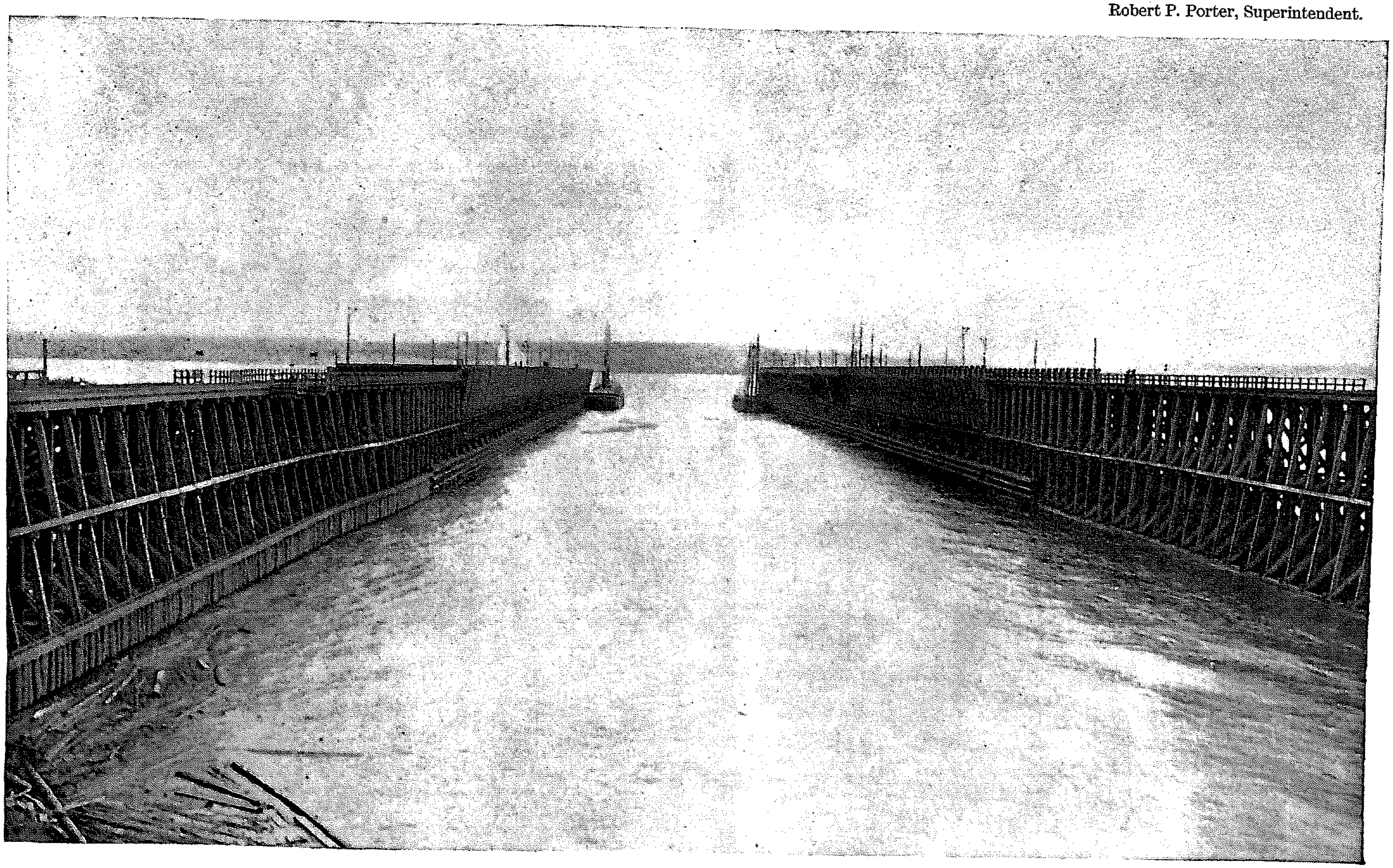
The foreign iron ore was received at the following ports, named in the order of their prominence:

IMPORTS OF IRON ORE, BY PORTS OF ENTRY.

[Long tons.]

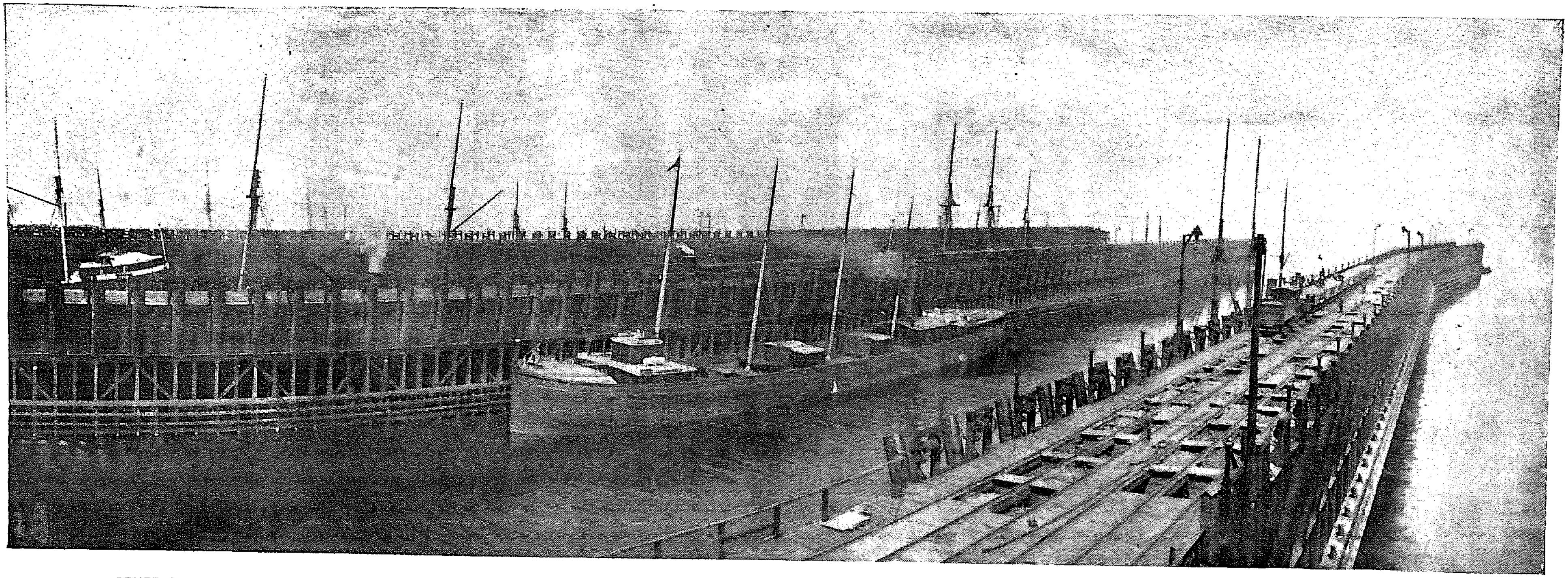
PORTS.	Quantity.	Value.
Total	853, 573	$1, 852, 392
Philadelphia, Pennsylvania	525, 124	1, 192, 141
Baltimore, Maryland	273, 050	519, 736
New York, New York	25, 824	72, 297
Puget Sound, Washington	13, 070	27, 860
Perth Amboy, New Jersey (a)	11, 558	26, 075
Oswego, New York	2, 309	6, 353
Cuyahoga, Ohio	1, 224	3, 403
Vermont district	462	707
Pensacola, Florida	135	608
Buffalo, New York	78	198
San Francisco, California	61	2, 525
Boston, Massachusetts	50	283
Detroit, Michigan	18	36
Chicago, Illinois	5	58
Pittsburg, Pennsylvania	4	88
Saint Louis, Missouri	1	24

a This port may also be classed under the head of ports of New York harbor.



GENERAL VIEW OF ORE SHIPPING DOCKS AT ASHLAND, WISCONSIN.

(See pages 27, 28.)



GENERAL VIEW OF ORE SHIPPING DOCKS, ESCANABA, MICHIGAN, SHOWING TRAINS OF CARS DISCHARGING ORE INTO POCKETS, AND VESSELS RECEIVING ORE FROM POCKETS.

(See pages 26–28.)

Grouping these ports, it is found that the receipts were as follows:

RECEIPTS OF FOREIGN IRON ORE, BY GROUPS OF PORTS.

[Long tons.]

PORTS.	Quantity.	Value.
Total	853,573	$1,852,392
Atlantic	835,741	1,811,140
Lake	3,634	10,048
Pacific	13,731	30,385
Miscellaneous	467	819

The high values attached to some of the smaller quantities shipped from a certain country or received at a specific port represent the importation of ores adapted for particular uses, owing to having in combination other minerals than iron.

The following statement, from information furnished by Mr. James M. Swank and others, showing the production of iron ore in such countries as furnished statistics, is given for purposes of comparison:

PRODUCTION OF IRON ORE IN THE YEAR 1889, BY VARIOUS COUNTRIES

	Tons.
Great Britain	14,546,105
United States	14,518,041
Germany and Luxemburg	11,002,187
Spain (shipments from)	5,067,144
France (*a*)	2,500,000
Austria-Hungary (*a*)	2,300,000
Russia (*a*)	1,500,000
Sweden	985,904
Algeria (*a*)	475,000
Cuba	256,278
Belgium	202,431
Italy	173,489
Canada	75,162

a Estimated.

The figures given above for Great Britain, the United States, Cuba, and Canada are tons of 2,240 pounds, and for the remaining countries the metric ton of 2,204 pounds.

COMMERCIAL VALUE OF IRON ORE.

The success of any iron-producing enterprise is largely contingent upon the character of the materials which are accessible. Until within a few years the fuel used attracted a large share of attention, and a blast furnace manager or proprietor gave less care to the ore used than to the fuel with which this ore was to be smelted. As, however, the amount of metallic iron and other constituents of an ore, and to a large extent the physical conditions of the ore, influence the smelting and affect the fuel consumption per ton of pig iron made, the subject of a proper ore supply for iron works has gradually won more attention from those who produce pig iron, and the policy of selling and purchasing iron ores on a unit basis is becoming more prevalent. This unit basis is a system for determining the value of an ore by the number of units of iron it contains in each 100 component parts, the price per unit being affected by the presence of other constituents than iron, and also by the number of units of iron in the ore; that is, an ore carrying 60 per cent or over of iron would command a higher price per unit than ore carrying 30 per cent or less, because a smaller amount of fuel and flux would be necessary under similar conditions to smelt a given quantity of it. Again, the unit price would be influenced by the amount of phosphorus or other materials in the ore, for if the phosphorus is greater than one part in 1,000 of iron the unit price would be considerably less than where the phosphorus was below this proportion.

In determining the value of different ores a number of factors must be considered. First, the amount of iron in the ore naturally attracts attention, and, the conditions being otherwise the same, a rich ore will require less fuel to smelt it, and therefore less cost for fuel than a leaner ore. Under ordinary circumstances a richer ore will also have less material to be fluxed out, and a smaller amount of limestone will be necessary for fluxing than where the iron is displaced by other constituents. The smaller amount of flux required further reduces the quantity of cinder made and the expense of providing room for this cinder and means for handling it.

Another important consideration is, that richer ores, requiring less fuel and flux, occupy less space in the blast furnace than the materials required in treating the lean ores, and generally permit of more rapid driving. Therefore rich ores will demand a smaller outlay in the cost per ton of product, for interest on the plant, management, and other fixed charges are divided by a greater tonnage than would be the case where lean ores are used. There is thus good reason for the price per unit being higher with rich ores than with lean ores. The unit basis was largely established by the importers of foreign iron ores, but it has been adopted to a limited extent by miners of domestic ores, and this method is gaining in favor.

Many of the iron ores of the country are sold under general market quotations by the long ton from calculations made on the unit basis, and each year finds the consumers and producers estimating iron ores more at the intrinsic value of the product of individual mines rather than on a general basis, although, of course, it is essential that some market standard should be established for any ore and for any district.

In buying and selling ores on the unit basis the most approved practice is to analyze the ore dried at or above 212° fahrenheit, so as to determine the amount of iron which the ore yields in the blast furnace; but this system has been objected to, because water is a practical constituent in ores until after the material is fed to blast furnaces, and as such is subject to all costs of freight, handling, etc. The hygroscopic moisture in magnetites seldom exceeds 2 per cent; it reaches 5 per cent in some red hematites, and often 15 per cent in brown hematites.

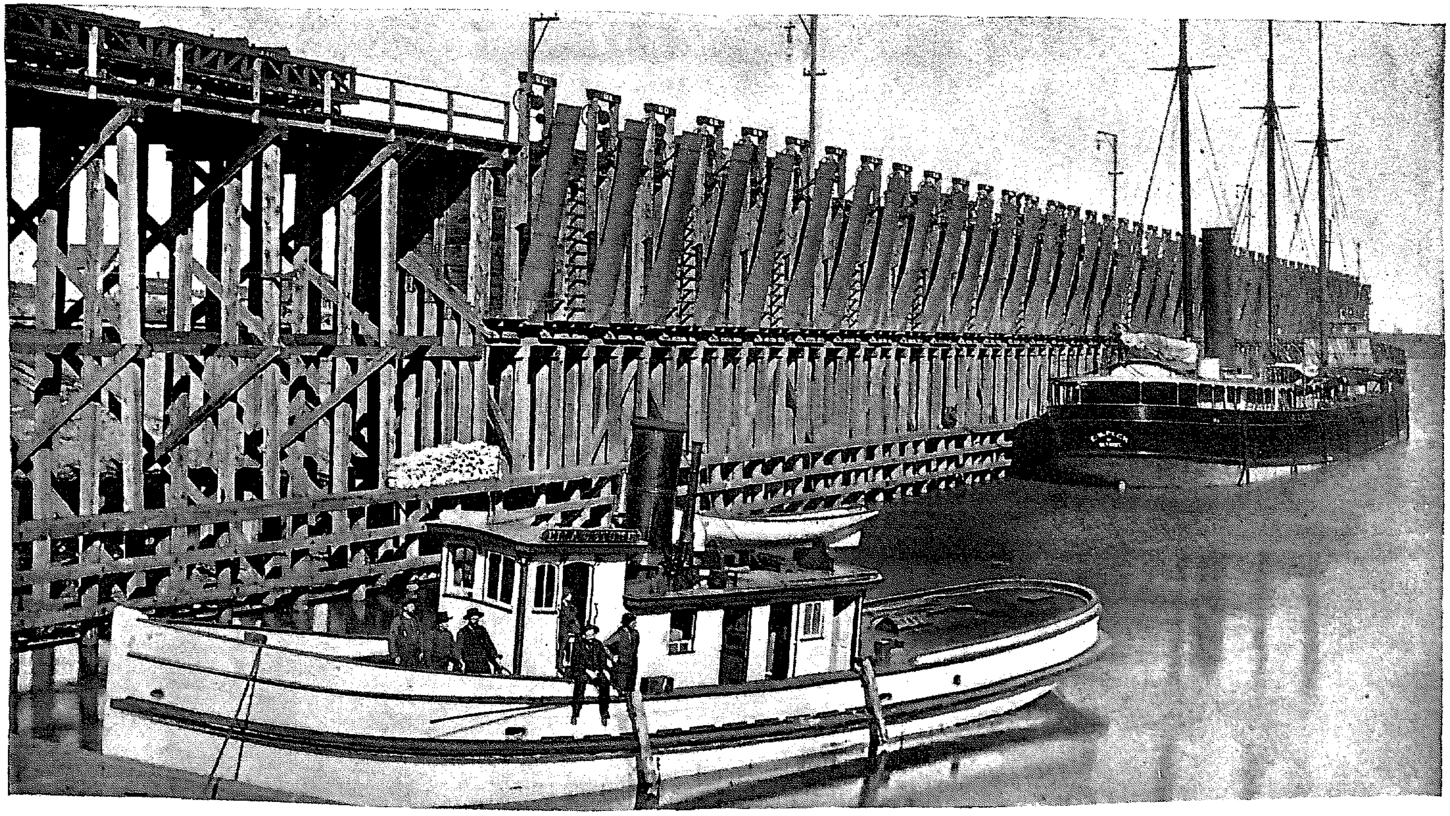
TRANSPORTATION AND HANDLING IRON ORES.

Probably in no country has the transportation of iron ore assumed such proportions as in the United States. A number of the European countries, and also the United States, have imported large quantities of iron ores from Spain, Italy, Greece, and Africa, but, taking into consideration the distance covered and the relative location of the domestic iron mines and blast furnaces, it is probable that in no other part of the world has so great an amount of iron ore been transported over such long distances, requiring so many handlings. The Lake Superior district is the most important contributor to this tonnage, having in the year 1889 shipped 7,390,387 long tons, and since its first opening, in 1853, furnished nearly 48,500,000 tons to the country's supply. Most of this ore has been, and now is, handled by lake vessels, but all-rail transportation has been growing in importance, not sufficiently, however, to materially affect the amount of ores sent forward by water. In each of the 4 districts forming the Lake Superior region the iron-ore mines are located at a distance from the lakes. In the Marquette range the nearest mines are 12 miles from a shipping port; in the Menominee range none of the mines are less than 41 miles from a shipping port. The center of the Gogebic range is 39 miles, and the Tower mines, in the Vermilion range of Minnesota, are 69 miles from a shipping point, while the mines at Ely are 26 miles farther removed. Not more than 30 per cent of the Lake Superior iron ore brought by vessels to lower lake receiving ports is consumed at these ports, but most of it is shipped by railroad to furnaces located from 60 to 475 miles from them.

The ore from Lake Superior mines is consumed by furnaces as far east as Troy, New York, eastern New Jersey, and southeastern Pennsylvania, and forms the bulk of the ore used in Allegheny county, Pennsylvania (the largest pig-iron producing center of the United States), as well as for furnaces in central Pennsylvania, in the Shenango valley in western Pennsylvania, in the Mahoning valley in eastern Ohio, and in the Wheeling district of West Virginia and southern Ohio. Chicago, the second largest pig-iron producing center, and Joliet, Illinois, are solely dependent on Lake Superior ores. In a number of instances Lake Superior ores in their routes to points of consumption cross ores shipped from other mining centers to other points of iron production. Thus, in reaching Troy, New York, the Lake Superior iron ores cross in transit ores from the Lake Champlain district and other northern New York points going south into Pennsylvania; and in gaining access to some of the points on the Ohio river the Lake Superior ores pass Missouri ores bound up the Ohio to furnaces farther east. They also form an important factor of the charge of blast furnaces in districts which produce large quantities of local ores, and in some of these, as in the Shenango district of Pennsylvania and the Mahoning district of Ohio, they practically displace the leaner local ores. In others, as in the Hocking region of southern Ohio, Lake Superior ores are used to enrich the ore mixture to a point which permits of furnaces being operated successfully, which could not otherwise run on the relatively inferior ores which abound in that section. The readiness with which the majority of these Lake Superior ores smelt also encourages their use in furnaces in New Jersey and eastern Pennsylvania which are conveniently located for a supply of the more refractory magnetites or which command large quantities of lean brown hematite ores.

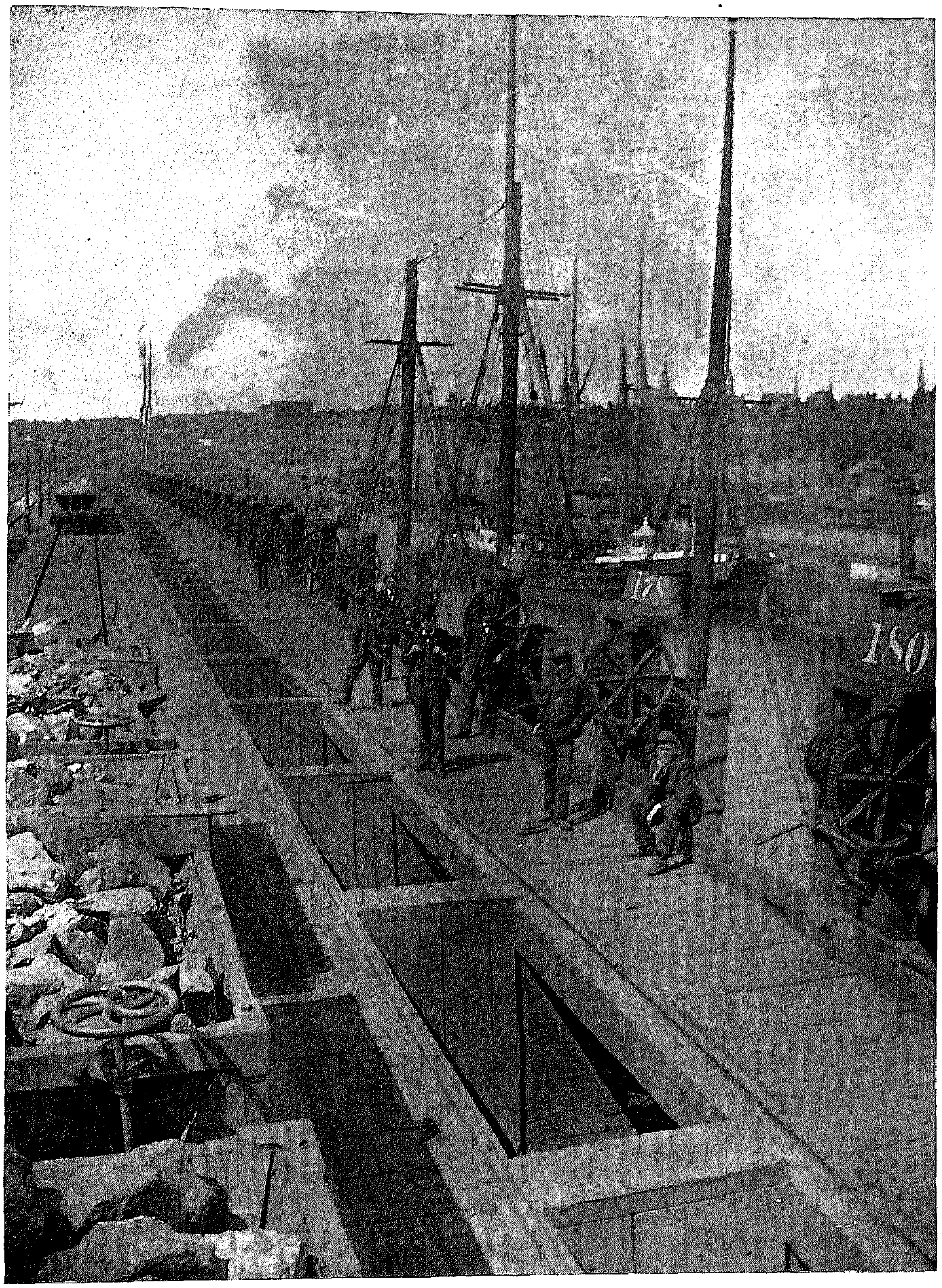
To obtain facilities for cheaply handling Lake Superior ores the railroads which penetrate the various districts have constructed expensive terminal facilities, consisting of one or more shipping docks, with the railroad tracks elevated from 35 to 47.5 feet above the water level, and with pockets, into which the ore from the cars is dumped by means of drop bottoms. From these pockets the ore is discharged by iron chutes, let down into the vessel's hold. In this manner the ore is never handled from the time it leaves the mine until it is shoveled into buckets when the vessel is discharged at lower lake ports, and no manual labor is necessary other than poking the ore with poles from the cars into the bin and from the bin into the chutes, and in some cases but little of this is required.

The shipping ports for the Lake Superior iron-ore district are 6, and from these 6,810,108 long tons were sent forward by water transportation in the year 1889. The most important port is Escanaba, Michigan, on Lake Michigan, from which 3,003,632 long tons were shipped in 1889, this amount being 44.11 per cent of the total shipments by vessel of Lake Superior ores during the year. The supply of ore for the Escanaba docks, 4 in number, came from the Menominee, the Marquette, and the Gogebic districts. All of the Menominee ore which required lake transportation (1,684,618 tons), 40.4 per cent of the ore from the Marquette range loaded into vessels (1,021,006 tons), and 16.7 per cent of the shipments from the Gogebic range (298,008 tons) were handled by these docks. The docks at Escanaba are operated by the Chicago and Northwestern Railway Company, and represent an aggregate length of 4,898 feet, the shortest being 1,082 feet long and the longest 1,500 feet. These docks have double tracks and an



SIDE VIEW OF ORE SHIPPING DOCK AT TWO HARBORS, MINNESOTA, SHOWING HINGED CHUTES AND A VESSEL IN POSITION TO RECEIVE ORE.

(See pages 27, 28.)



TOP VIEW OF AN ORE SHIPPING DOCK AT MARQUETTE, MICHIGAN, SHOWING THE WINCHES FOR HANDLING HINGED CHUTES, THE TOP OF THE BINS, AND LOADED CARS READY TO BE DISCHARGED. (See page 27.)

aggregate of 828 pockets, which contain a total of 95,500 tons. The outlay required for their construction and equipment was about $1,000,000.

Ashland, Wisconsin, on Lake Superior, ranked second in 1889 as a shipper of iron ore, 1,484,802 tons, or 21.80 per cent of the total lake shipments of the Lake Superior district, having been hauled to the 3 docks at this point. This ore was from the Gogebic range, and the amount handled at Ashland and that passing through the docks at Escanaba represent the total shipments by water from the Gogebic range in 1889 (1,782,810 tons). 2 of the docks at Ashland are operated by the Milwaukee, Lake Shore and Western Railroad Company, and 1 by the Wisconsin Central Railroad Company. They were constructed at a total cost of $739,000. The docks are 1,404 feet long, making the aggregate 4,212 feet. They each have 234 pockets, giving a total of 702 for the 3, the aggregate capacity being 78,250 tons. 2 of the docks accommodate 3 tracks, and 1 of them 4 tracks.

Following close upon Ashland is Marquette, Michigan, on Lake Superior, which in 1889 shipped 1,376,335 tons, being 20.21 per cent of the total lake shipments of the entire district for that year. This ore was all from the Marquette district, and represented 54.6 per cent of the ore forwarded by the lakes from the Marquette range. Additional facilities lately added give promise of Marquette recovering her position as a shipping point for iron ores. It has 4 ore docks, operated by the Duluth, South Shore and Atlantic Railway Company. They vary in length from 600 to 1,600 feet, the aggregate being 4,900 feet. The total number of pockets in the 4 docks is 798, and the total capacity is 74,000 tons. 3 of the docks accommodate 3 tracks, and 1 has 4 tracks.

A comparatively small amount of ore from the Marquette range was handled at the ports of Saint Ignace and Gladstone, Michigan, on Lake Michigan, the former shipping 51,853 and the latter 73,847 tons, being 2.1 and 2.9 per cent, respectively, of the lake shipments from the Marquette range and 0.76 and 1.08 per cent of the total lake shipments of iron ore. The dock at Saint Ignace is 800 feet long, and is operated by the Duluth, South Shore and Atlantic Railway Company. It has 100 pockets, with an aggregate capacity of 10,000 tons, and supports 3 railroad tracks. There is also an ore dock at L'Anse, Michigan, on Lake Superior, which was not used during 1889. This dock is 1,000 feet long, has 100 pockets, and an aggregate capacity of 8,000 tons. It was formerly used for some of the shipments from the Marquette range.

The ore from the Vermilion range in Minnesota is transferred from cars to vessels at Two Harbors, Minnesota, on Lake Superior. The Duluth and Iron Range railroad has 2 docks here, each 1,056 feet long, making an aggregate of 2,112 feet. They accommodate double tracks, and have a total of 303 pockets, the aggregate capacity being 40,000 tons. $800,000 was expended in constructing these docks. The amount of ore handled at Two Harbors during the year 1889 was 819,639 tons, all of which came from Minnesota, and represented 12.04 per cent of the total lake shipments from the Lake Superior region.

The accompanying plates illustrate the construction, arrangement, and equipment of ore shipping docks at Escanaba and Marquette (Michigan), and Two Harbors (Minnesota). The heights, lengths, number of pockets, capacity in long tons, and number of tracks of each of the docks are detailed below. The plates exhibit views of the tops of the docks, and show openings to the ore pockets, some of which are filled with ore. On the tracks which pass over these pockets locomotives and trains of cars are seen. The drop-bottom cars discharge into the pockets, the sides of which slope toward the water front of the dock, gradually contracting toward the bottom, where the openings are closed by doors. When vessels to be loaded are made fast to the sides of the docks and hatches removed the semicircular iron chutes are let down into each hatchway by means of winches and chains, and when the doors of the pockets are opened the ore is discharged by gravity into the hold of the vessel. The semicircular chutes are exhibited as in position for discharging the ore from the pockets. These semicircular chutes are seen extending above the top of the first dock, and one is being lowered from the second dock. The presence of numerous vessels at, and of trains of ore cars on, each dock is a representation of daily operation during the shipping season. Other ore-shipping docks are similar to those illustrated, but each possesses some peculiarity of construction or detail.

SHIPPING DOCKS.

The following is a list of shipping docks specially constructed for handling iron ore from the Lake Superior region, together with their capacity, etc:

The Duluth, South Shore and Atlantic Railway Company at Marquette, Michigan, has 4 docks, and 2 others at L'Anse and Saint Ignace, Michigan, of the following description:

No. 1.—Height of dock above water, 42 feet; length of dock, 1,300 feet; number of pockets, 220; number of tracks, 3; capacity, 15,000 long tons.

No. 2.—Height of dock above water, 35 feet; length of dock, 600 feet; number of pockets, 78; number of tracks, 3; capacity, 4,000 long tons.

No. 3.—Height of dock above water, 44 feet; length of dock, 1,600 feet; number of pockets, 300; number of tracks, 3; capacity, 25,000 long tons.

No. 4.—Height of dock above water, 47.5 feet; length of dock, 1,400 feet; number of pockets, 200; number of tracks, 4; capacity, 30,000 long tons.

The ore dock at L'Anse, Lake Superior, Michigan, is described as follows:

Height of dock above water, 38 feet; length of dock, 1,000 feet; number of pockets, 100; capacity, 8,000 long tons.

The ore dock at Saint Ignace, Michigan, is described as follows:

Height of dock above water, 42 feet; length of dock, 800 feet; number of pockets, 100; number of tracks, 3; capacity, 10,000 long tons.

The cars built especially for ore trade by this company include 3,200 hopper-bottom 8-ton capacity cars and 600 hopper-bottom 20-ton capacity cars.

At Escanaba, Michigan, the Chicago and Northwestern Railway Company has 4 double ore docks, as follows:

No. 1.—Height of dock, 46 feet; length of dock, 1,104 feet; number of pockets, 184; number of tracks, 2; capacity, 23,000 long tons.
No. 2.—Height of dock, 39 feet; length of dock, 1,082 feet; number of pockets, 192; number of tracks, 2; capacity, 19,300 long tons.
No. 3.—Height of dock, 39 feet; length of dock, 1,212 feet; number of pockets, 202; number of tracks, 2; capacity, 20,000 long tons.
No. 4.—Height of dock, 46 feet; length of dock, 1,500 feet; number of pockets, 250; number of tracks, 2; capacity, 33,200 long tons.

The cost of the 4 ore docks at Escanaba was $922,000; cost of cars, $1,368,000; a total of $2,290,000. The company uses in the distribution of the ore 3,300 small cars of from 7 to 10 tons capacity and 1,800 large cars of 20 tons capacity.

At Two Harbors, Minnesota, the Duluth and Iron Range Railroad Company has 2 double ore docks, as follows:

No. 1.—Height of dock, 47 feet; length of dock, 1,056 feet; number of pockets, 162; number of tracks, 2.
No. 2.—Height of dock, 46 feet; length of dock, 1,056 feet; number of pockets, 141; number of tracks, 2.

The capacity of both ore docks is 40,000 long tons. The cost or value of the 2 docks is $800,000, and the value of the 750 cars is $431,250, a total of $1,231,250. The company has 750 double-hopper 8-wheel ore cars, having a capacity of 50,000 pounds each.

At Ashland, Wisconsin, the Wisconsin Central Railroad Company and the Milwaukee, Lake Shore and Western Railroad Company have iron-ore docks.

The Milwaukee, Lake Shore and Western Railroad Company has 2 docks, as follows:

No. 1.—Height of dock, 40 feet; length of dock, 1,404 feet; number of pockets, 234; number of tracks, 4; capacity, 23,000 long tons.
No. 2.—Height of dock, 45 feet; length of dock, 1,404 feet; number of pockets, 234; number of tracks, 3; capacity, 27,000 long tons.

The 2 ore docks are valued at $483,000, and the 850 cars at $330,000, a total of $813,000. Of the cars, 800 have a capacity of 45,000 pounds and 50 a capacity of 60,000 pounds each.

The Wisconsin Central Railroad Company has 1 double ore dock, as follows:

Height of dock, 46 feet; length of dock, 1,404 feet; number of pockets, 234; number of tracks, 3; capacity, 28,250 long tons.

The dock cost $256,000, and the cars $388,800, a total of $644,800. Of the cars, 789 have a capacity of 50,000 pounds each, and 90 drop-bottom gondola cars have each 40,000 pounds capacity.

Among the iron-mining companies which have a considerable investment in vessels used in the transportation of iron ore are the Republic Iron Company, the Minnesota Iron Company, the Cleveland Iron Mining Company, the Lake Superior Iron Company, and the Chapin Mining Company.

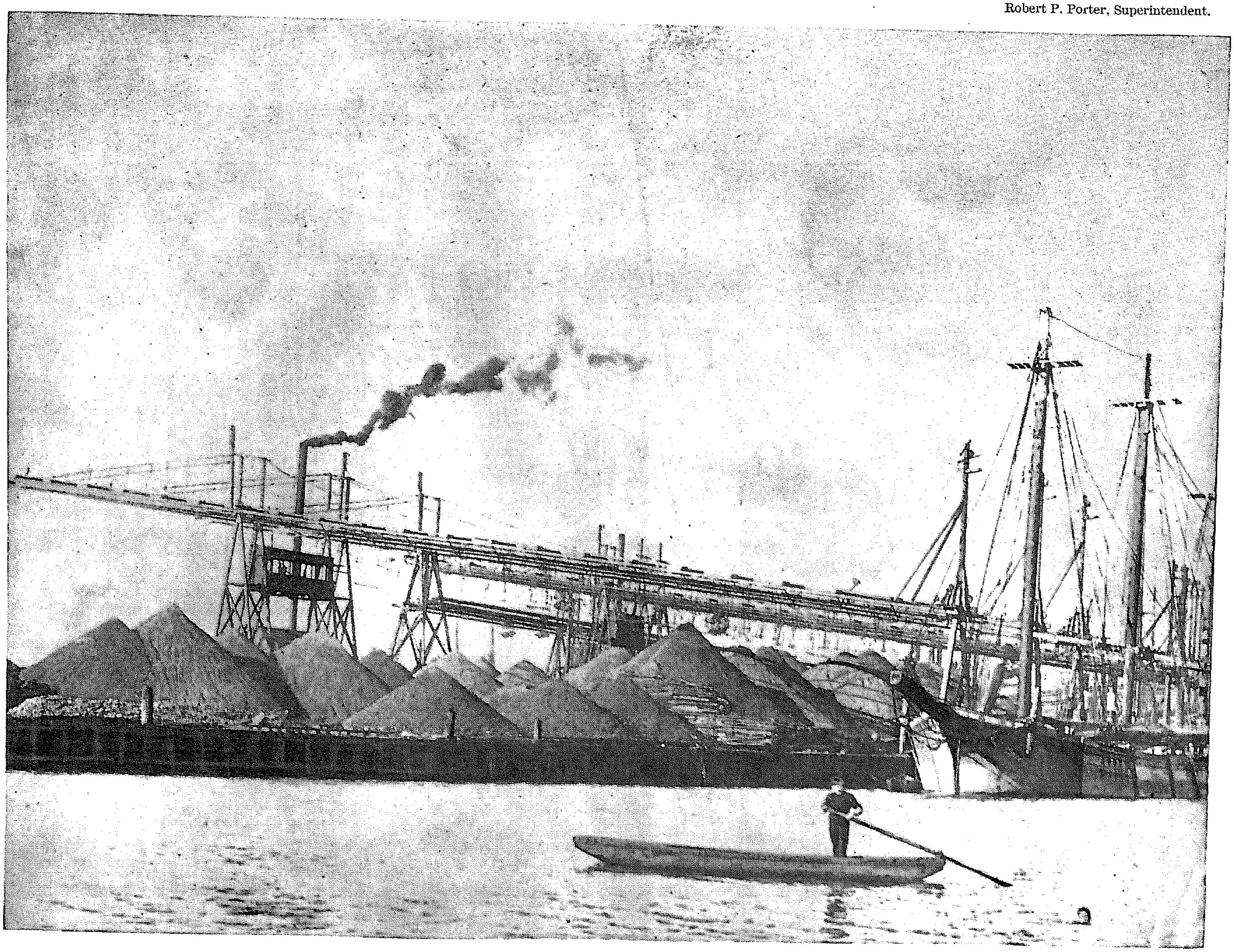
The description, size, and cost of the docks above mentioned could be supplemented by a number of others, which, however, would not equal the capacity or the outlay required in those given. The mines which produced magnetite in the vicinity of Lake Champlain transport a considerable portion of their output each year by canal, the ore being brought to the lake by cars and then loaded from docks into boats. In addition, as the locations of the mines are upon either individual or narrow-gauge railroads, the companies' cars are not taken beyond their own road and transfer chutes are erected to facilitate loading into trunk line cars.

As instances of the location of additional shipping docks, the following may be mentioned: Plattsburg, Port Henry, and Crown Point, on Lake Champlain; Burden and Fort Montgomery, on the Hudson river, and below Saint Louis, on the Mississippi river.

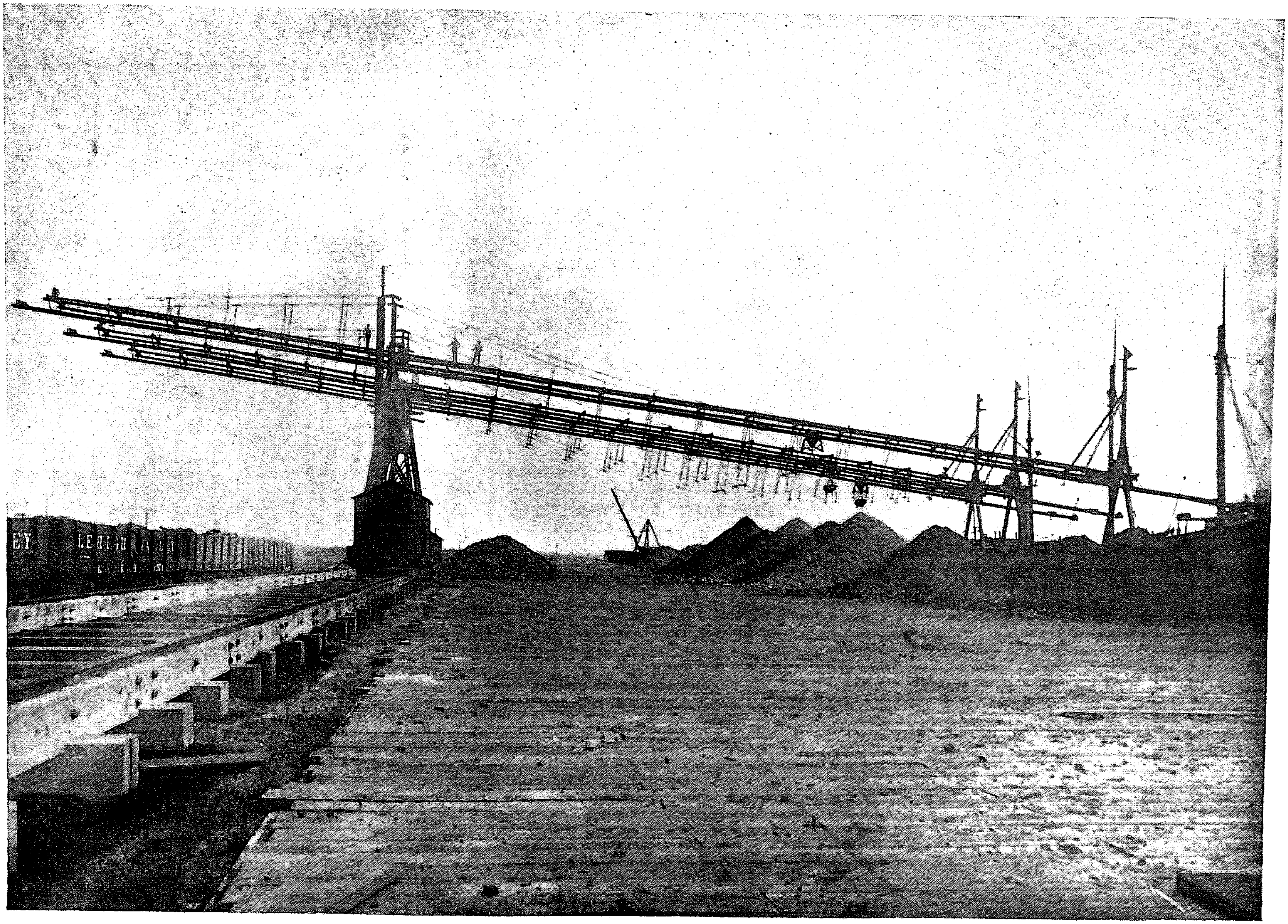
The total investment for docks especially built and equipped for handling and shipping iron ore approximated $4,000,000 in the year 1889.

RECEIVING DOCKS.

The subject of ore transportation would be incomplete unless, in addition to the ore-shipping docks, mention was made of the ore-receiving docks, which have been especially constructed for the purpose of handling the ore to blast furnaces or at points from which railroads radiate to blast furnaces. The blast furnaces at Milwaukee (Wisconsin), Chicago (Illinois), Detroit (Michigan), Cleveland (Ohio), Tonawanda (New York), as well as those along the shore of Lake Michigan, have docks more or less extensive and equipped with steam handling machinery for the removal of ore from the holds of vessels which bring the ore from the shipping docks on Lakes Michigan and Superior. There are also docks owned by railroad companies or by corporations located on Lake Erie at Toledo, Sandusky, Huron, Lorain, Cleveland, Fairport, and Ashtabula (Ohio), at Erie (Pennsylvania), and at Buffalo (New York). Cleveland has 4 such docks, Buffalo 3, Ashtabula and Fairport 2 each, the balance of the points named having 1 ore dock each. The largest of these ore docks at Fairport, Ohio, has a frontage 1 mile in length, with room for stocking ore extending back 180 to 350 feet in width. The 2 docks at Cleveland are one-half mile in length, with a storage capacity 350 feet wide. The capacity of the 3 docks named will reach from 1,000,000 to 1,500,000 long tons



RECEIVING DOCK FOR IRON ORE, CLEVELAND, OHIO, SHOWING WATER FRONT, VARIOUS ORES STACKED IN PILES, AND BRIDGE TRAMWAY CONVEYING APPARATUS. (See pages 28, 29.)



FLOOR OF AN ORE RECEIVING DOCK, CLEVELAND, OHIO, WITH BRIDGE TRAMWAY CONVEYING APPARATUS IN POSITION, ORE ON DOCK, RAILWAY AND CARS IN POSITION FOR LOADING, AND THE TRAVERSING TRACKS ON WHICH BRIDGE TRAMWAYS MOVE LENGTHWAYS ON THE DOCK. (See pages 28, 29.)

each, as the ore is stored from 25 to 50 feet in height; but owing to the necessity of keeping the various kinds of ore and that from different mines separate and the constant demand for ore, the docks never carry their maximum capacity. About one-third of the ore as it is received is handled directly from the vessels bringing it from the upper lakes into railroad cars during the 7 months of the shipping season, and about two-thirds are placed in stock on docks, from which regular shipments of ore are continuously made, but toward the close of the shipping season there is usually a large accumulation on docks for shipment during the winter to blast furnaces. The storage capacity of these receiving docks varies from 300 to 500 tons per front foot of dock, and the machinery employed in those of new construction is such as to remove the weight of ore from the dock front to insure stability, and in many cases the steam machinery which takes the ore from the hold of the vessel to the stock pile is also used to convey it from stock piles to railroad cars.

Mr. Alexander E. Brown, of Cleveland, Ohio, who has made a specialty of equipping docks and handling large quantities of iron ore, states that the ore from the Lake Superior region, when loaded into cars, occupies from 10 to 16 cubic feet per long ton, the average approximating 14 cubic feet. If, however, these ores are piled in large quantities on docks, the space occupied varies from 10 to 13 cubic feet per long ton of ore. In handling this ore in buckets, where it is loosely placed, the volume is somewhat greater, the average per long ton determined by a number of experiments being 13.625 cubic feet for Marquette and 15.2 cubic feet for the Gogebic and Menominee ores.

The machinery equipment of the various docks differs greatly, but 5 general types may be mentioned: (1) swing-boom derricks, operated either with engines placed on them or driven by wire rope from engines at a distance; the mast being either stationary or carried on trolleys, the iron buckets are lowered into the holds of vessels, where the navvies shovel the ore into them, the steam machinery raising the buckets and swinging the boom to the point where the ore is to be deposited; (2) a similar arrangement of swing-boom derricks, discharging into hoppers and from these into tram cars, which carry the ore from the ore dock to stock piles, located at a considerable distance from the water; (3) an A frame which lifts with the buckets and discharges them into tram cars that run to the stock pile or dump into pockets and thence into cars; (4) aprons which project over the holds of vessels; the buckets traveling up the incline of this apparatus are dumped into tram cars, which run by gravity, discharge, and return automatically; (5) booms or aprons upon which the buckets are carried and continue their journey either over cables or on trussed bridges, the buckets dumping automatically at the point desired and returning to the hold without detaching from the machinery.

These dock equipments have been put up at great expense, some of the docks costing equipped over $800,000, and by them it has been possible to handle quantities of ore which could not be moved in any other way, while the cost of such handling has been reduced to a minimum. The expense of shoveling the ore into buckets in the holds of vessels varies from 10 to 15 cents per long ton, the rate being controlled by stevedores, while with the improved apparatus at some of the docks this ore in buckets is lifted from the vessel, carried back 350 feet and dumped, at a total cost, including labor, wear and tear, interest, and fuel account reported, of from 1 to 1.5 cents per ton. With 21 men in the hold of a vessel carrying 2,000 long tons of iron ore the entire cargo has been stocked in 17 hours. Other instances are mentioned where with 28 men 2,200 long tons were similarly handled in 15 hours, and 2,100 long tons were handled by 18 men in 17 hours. In using these improved apparatuses in loading from stock piles to railroad cars it is not uncommon to have a gang of men shoveling into buckets and load the ore on cars at the rate of 8 or 9 tons per man per hour.

Receiving docks at some of the blast furnaces located on navigable streams will, together with those above instanced, augment the capital invested in such facilities to an amount equal to the outlay mentioned as demanded for the shipping docks.

The accompanying plates represent receiving docks at Cleveland, Ohio, giving a general view of the bridge tramway plants used in unloading iron ore from vessels, consisting of a series of bridges, supported at their ends upon frames which traverse on rails. On one of the frames is a house containing the motive power, including boiler, hoisting engine, brakes, etc. Each bridge frame has a hinged connection in front, which permits of the apron being moved to suit the hatchways of the vessels. Both front and back frames are mounted on wheels, the first named moving on a single rail and the others on double rails. The buckets are filled in the hold of the vessel, hoisted and lowered to cars below or automatically dumped at the proper place on the dock, as may be required, the varieties of ore being placed in separate piles. A view of the floor of one of the receiving docks, exhibiting the various stock piles and bridge tramway plant, is also given. The third plate illustrates the water side of the receiving dock, showing a rear view of the apron.

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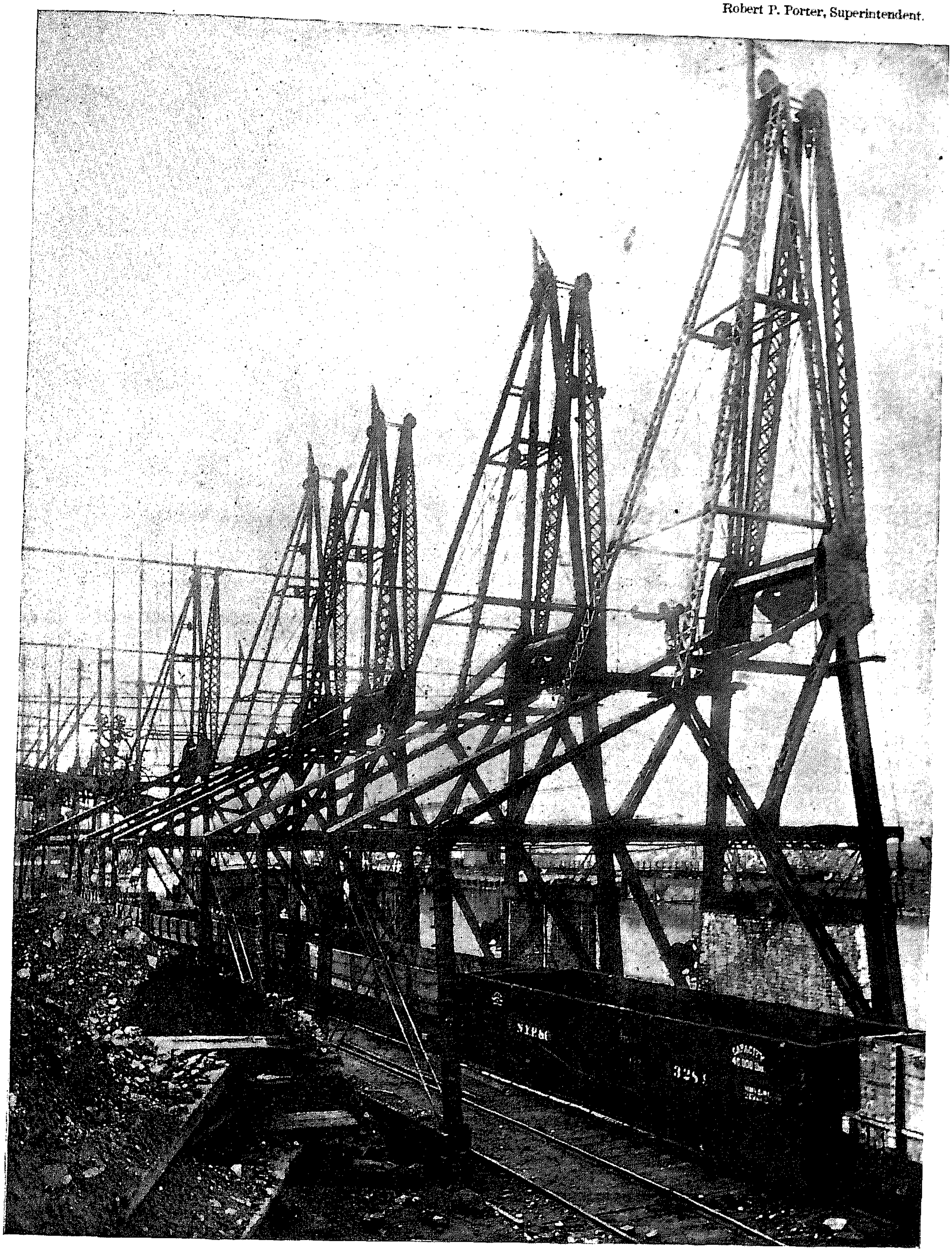

NEAR VIEW OF "A" FRAMES AND PROJECTING APRONS OF A RECEIVING DOCK. (See page 29.)

The aprons are lowered from the position shown when ore is being taken from vessels.